Journal of Science and Technology Metrics

ISSN: 2582-6956

DLINE JOURNALS

JSTM 2024; 5 (2)
https://doi.org/10.6025/jstm/2024/5/2/33-44

Growth of a Domain from Multiple Bibliometric Perspectives: The Case Study of Organic Chemistry

M Sivamani
Vellalar College for Women - Autonomous
Erode-12
India

ABSTRACT

In this work, we took the Organic Chemistry domain, identified this field's output for 15 years, and analysed the growth in multiple models. It ranges from simple growth to a complex measure of compound growth. We also divided the study period into many blocks and reported the findings. We found that the measure of growth is not simple and goes beyond number count.

Keywords: Simple Growth, Relative Growth, Compound Growth, Organic Chemistry, Scientometric study

Received: 7 February 2024
Revised: 11 May 2024
Accepted: 20 May 2024

1. Introduction to Metric Studies

Scientific tools and techniques are essential to analysing the inherent characteristics of information to assess the quality of information. There are several problems associated with information patterns, and obtaining the accuracy and relevancy of information according to research is challenging. Charles Bermier stated, "Today's scientific literature is so large that one person can no longer read the output in any subject branch". In response, information professionals have played a pivotal role in formulating various theories, laws, and formulas to determine the publication patterns of information, analyse techniques, measure utility rates, and assess quality indicators to detect scholarly knowledge. Their contributions to metric studies are integral to information research, drawing the publication pattern, growth of information, and collaborative measures among countries, institutions, and subjects.

Science indicators, the advanced outcomes of a complex interaction between process and measurement, serve as a lens into the current state of evolution of science and technology enterprises globally. They illuminate the structure and relations within a state or across the world, aiding in the understanding of ongoing activity, progress, and desired outcomes in the field of science and technology. In essence, they keep us abreast of the latest developments, playing a crucial role in our awareness and knowledge.

In this work, we studied the domain of Organic Chemistry using bibliometric indicators and documented the findings, which will help us understand its structure and growth. Section 2 reports some related studies on domain analysis, followed by methods and materials. The next section reports the data analysis, followed by an extensive discussion, and finally, we conclude the work.

2. Earlier Studies

As a research technique, bibliometrics and scientometrics have been used to study the literature growth, pattern or trend of research, and productivity rate of authors and Co-authorship patterns in any given field. The literature search in this area has grown tremendously to understand country-wise research and the impact of research outcomes worldwide. The process of literature search attempts to identify if any similar study has already been conducted and to get an idea of the research process and application of statistical packages to analyse the data. Mulay (1969) has pointed out that "the survey of literature is a crucial aspect in the planning of the body and the time spent in such a survey, invariably is wise statements." By this method, numerous pieces of literature are collected and reviewed for the study areas so that the duplication of work will be avoided and a research gap in the research area will be found.

Dwedi, Kumar and Garg (2015) examined the scientometric analysis of an Indian organic chemistry research profile from 2004 to 2013 and reported a few major domain analysis results.

Domain analyses were performed by many bibliometric researchers, which include Nagarkar. S (2014), Kumar (2014), Ramin, S., Gharebaghi, R., & Heidary, F. (2015). Murugan, Saravanakumar and Thirumagal (2015), Dwedi.S, Kumar and Garg (2015), Sampaio et al. (2016), Guskov. A., Kosyakov D. & Selivanova (2016), Machado et al. (2017), Garg and Tripathi (2017) and others.

Researchers worldwide reviewed several studies on bibliometric and scientometric studies. These studies can be categorized as below.

- Bibliometric techniques
- Scientometric study
- Altmetric tools
- Web of Science and
- Scopus
- Bibliometric laws
- Tools and techniques for citation analysis

In scientometric studies, authorship patterns, journal performance, and institutional productivity and impact are analysed using various indicators and tools, such as VOS viewer, Bibexcel, and Excel spreadsheets. Databases such as Scopus, WoS, EI, and other products are usually sourced.

The maximum number of studies was conducted using the Web of Science and Scopus databases to retrieve data, and only a few studies were made on institutional contributions and journals

3. Research Statement

Because science publication and dissemination are still significant, the proliferation of information, the source of information, the origin of information, the availability of information, the pattern of information, its consistency, and its credibility are measured. This study addresses the following research questions.

What is productivity, and how is it measured?

What are the forms of output to be measured?

How do you assess the quality of information?

Where do you find the origin of information and its credentials?

Which statistical tools and techniques are available to measure scientific productivity?

What percentage of papers is published in each country or institution?

Which country or region has the potential for organic research?

The study is conducted to find suitable parameters to assess the growth in terms of output that help to model the domain. We intend to study a few variables related to bibliometric data using the publication records in Organic Chemistry over a given period.

The study used scientometric and bibliometric techniques to analyse the research productivity in organic chemistry. The researcher used the Web of Science citation database covering 2006 -2021 for the analysis.

The bibliographic citations were obtained from the Web of Science database, published from 2006 to 2021, whereas 39551 articles were published until 31st December 2021. A basic search was conducted to find cumulative literature related to organic chemistry, and an advanced search to find subfields related to organic chemistry. The major fields were organic chemistry or organic compounds and organic molecules. Keywords are added in the advanced search based on major and subfields. The search strategy *AND, OR* terms are used to find relevant information related to organic, and the NOT operator is used to remove irrelevant items from the results. It also used pre-processed data related to chemistry from the Web of Science core collection. The filter was applied to cover the study period from 2006 to 2021. The researcher conducted a search term for publication titles, and extracted data was exported using plain text and tab-delimited format of 500 records per time, which were downloaded from the Web of Science core collection.

Data analytics is essential to any research where we extract valuable information from a large amount of data. Data from databases or archives allows us to recognise research and publication trends quickly and customise information products or libraries to meet user information requirements. In this research, we downloaded and analyzed the citation data from the study using quantitative and qualitative aspects.

We used scientometric techniques to evaluate the literature pattern in organic chemistry. Much open-source software exists to manage and analyse citation data and conduct various analyses. Scientometric software allows users to draw graphical representations of scientific research. Microsoft Excel was used to analyse the distribution of publications, including the total number of publications (TOP), number of papers (POP), and number of citations (NQ). The researcher used VOS viewer to perform authorship mapping and *Biblioshiny* to analyse empirical laws of bibliometrics.

4. Analysis and Results

To begin the analysis exercise, we measured the number of papers from 2006 to 2012 as reflected in the WoS database. Like any other domain, the studied discipline of Organic Chemistry reported a growth in scientific output.

Table 1 and Figure 1 show the year-wise research output of organic chemistry. A total volume of 39551 papers was published from 2006 to 2021. The year-wise distribution of publications has been calculated for three blocks of years. In the first five-year period, 2009 had the highest publication with 1941 (4.90%), the second block of the year 2015 had the highest publication, 2599 (6.57%), third block year 3291 (8.32%). In contrast, the percentage of publications climbed gradually between the middle of the year and 2021. However, the maximum number of publications in 2021 is 3291 (8.32%), and the least in 2008 is 1845

S. No.	Year	Record count	Cumulative count	Percentage
1	2006	1800	1800	4.55
2	2007	1854	3654	4.68
3	2008	1845	5499	4.66
4	2009	1941	7440	4.90
5	2010	1980	9420	4.95
6	2011	2187	11607	5.10
7	2012	2291	13898	5.79
8	2013	2437	16335	6.16
9	2014	2539	18874	6.41
10	2015	2599	21473	6.57
11	2016	2784	24257	7.03
12	2017	2870	27127	7.25
13	2018	2889	30016	7.30
14	2019	3069	33085	7.75
15	2020	3175	36260	8.02
16	2021	3291	39551	8.32
Total		**39551**		**100**

Table 1. Year-Wise Research Output of Organic Chemistry

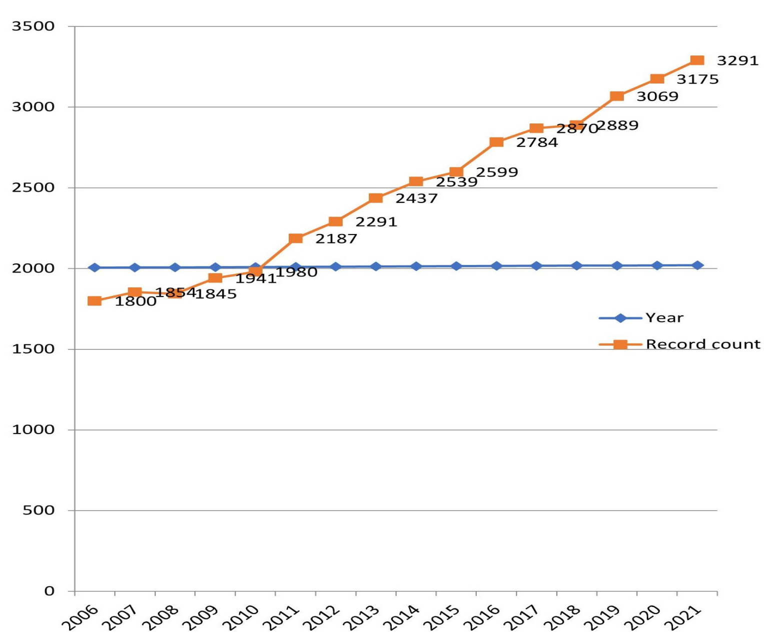

Figure 1. Year-Wise Research Output of Organic Chemistry

(4.61%). The results revealed that the overall productivity of publication in organic chemistry did not show steady growth in the beginning years, and a slow growth rate was found in the entire study. This simple data indicates a regular but slow growth without any skewness.

The study's results showed the year-wise output of publications between 2006 and 2021. The mean growth during the initial five-year period was a mere 4.5 per cent. Then, growth was reported to be slow from 2011 to 2021. No significant growth was found during the study period. This is because the beginning size of the publication count from 2006 was 1800, that is (4.55%), and the 2021 count was 3291, which is 8.32 and influences the year count. Hence, there is no association between the growth of publications and year-wise output.

Figure 2 depicts the publication output year-wise as a line chart with markers for the number of documents in one line, the year of publishing in another, and a line that gradually increases in value from 2009 to 2021.

S. No.	Block	Year-Wise	Record Count	Percentage	Total Record Count	Average publication per block	Total Percentage
1.	1 -4	2006 2007 2008 2009	1800 1854 1845 1941	4.55 4.68 4.66 4.90	7440	1860	18.81
2.	5 -8	2010 2011 2012 2013	1980 2187 2291 2437	4.95 5.10 5.79 6.16	8895	2223.75	22.48
3.	9-12	2014 2015 2016 2017	2539 2599 2784 2870	6.41 6.57 7.03 7.25	10792	2698	27.28
4.	13 -16	2018 2019 2020 2021	2889 3069 3175 3291	7.30 7.75 8.02 8.32	12424	3106	31.41
TOTAL			**39551**	**100**	**39551**		**100**

Table 2. Block Year-Wise Distribution of Research Productivity

Tables 2 and Figure 2 explain block year-wise distribution of analysis of research productivity during 2006-2021. The growth is measured in less than four years, and each block was analysed for individual year-wise productivity, and its growth was calculated. In the first block, the majority of publications were produced in 2009, with 1941 articles (4.90%) and fewer articles were produced in 2008, with 1845 articles (4.66%); in the second block year, 2013, the maximum number of articles reported as 2437 (6.16%), in third block year 2017 was a maximum number of articles with 2870 (7.25%) and last block year 2021 was produced a maximum number of articles with 3291 (8.32%). However, the importance of organic chemistry research has been realised since the third block year, 2014, when 31.41 per cent of growth appeared in the last block period of 2021. We infer from the table that the maximum growth of the study period is found under the 4th block period, with 12424 (31.41%) records published, followed by the 3rd block period.

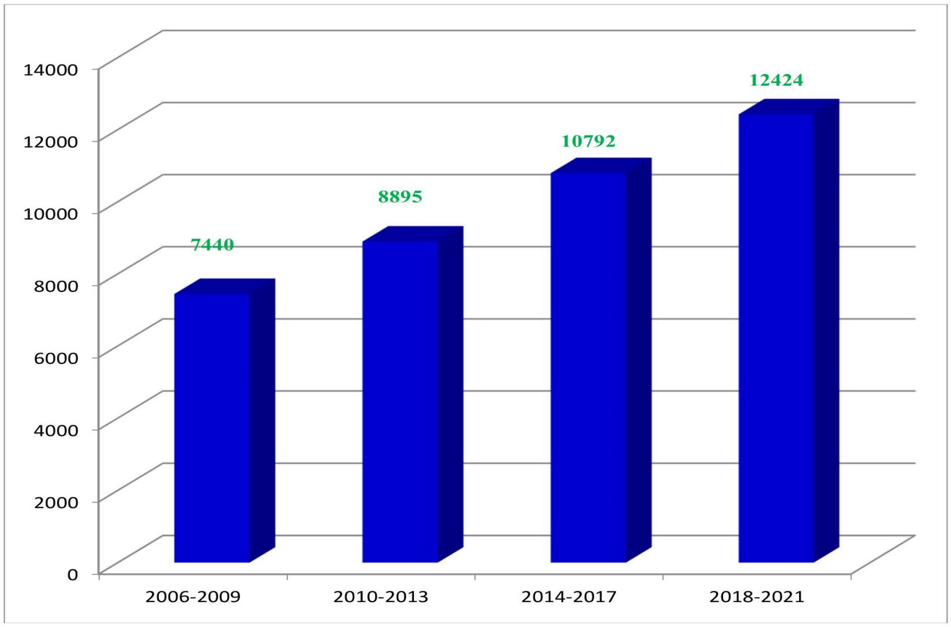

Figure 2. Block Year-Wise Distribution of Research Productivity

S. No.	Year	Record count	Cumulative Count	log W1	log W 2	RGR	Mean RGR	DT	Mean DT
1.	2006	1800	1800	0	8.203	0		0	
2.	2007	1854	3654	8.203	8.612	0.409		1.694	
3.	2008	1845	5499	8.612	8.914	0.302	0.267	2.294	2.818
4.	2009	1941	7440	8.914	9.15	0.236		2.936	
5.	2010	1980	9420	9.15	9.359	0.209		3.315	
6.	2011	2187	11607	9.359	9.539	0.180		3.851	
7.	2012	2291	13898	9.539	9.701	0.162		4.277	
8.	2013	2437	16335	9.701	9.845	0.144		4.812	
9.	2014	2539	18874	9.845	9.974	0.129	0.133	5.372	5.265
10.	2015	2599	21473	9.974	10.096	0.122		5.68	
11.	2016	2784	24257	10.096	10.208	0.112		6.187	
12.	2017	2870	27127	10.208	10.309	0.101		6.861	
13.	2018	2889	30016	10.309	10.406	0.097		7.144	
14.	2019	3069	33085	10.406	10.498	0.092	0.080	7.532	7.675
15.	2020	3175	36260	10.498	10.585	0.087		7.965	
16.	2021	3291	39551	10.585	10.609	0.024		8.875	
Mean						**0.1604**		**5.253**	

Table 3. Relative Growth Rate and Doubling Time

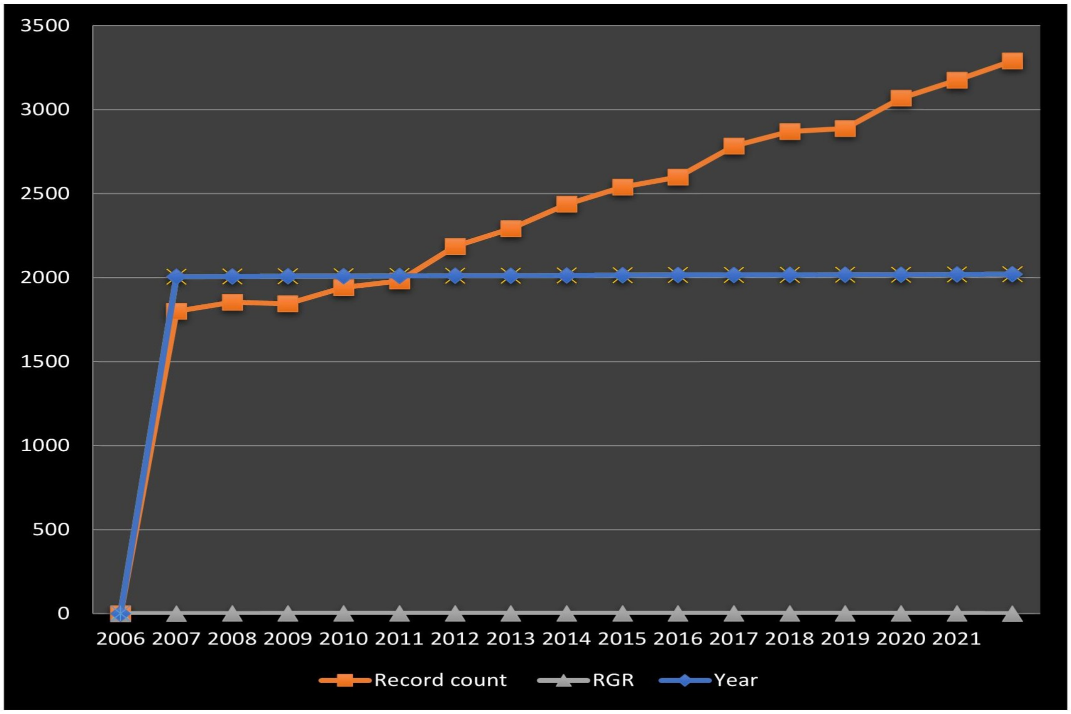

Figure 3. Relative Growth Rate in the Study Period

Table 3 defines organic chemistry's relative growth rate (RGR) during a study period. From 2006 to 2021, the RGR ranged from 0.409 to 0.024.

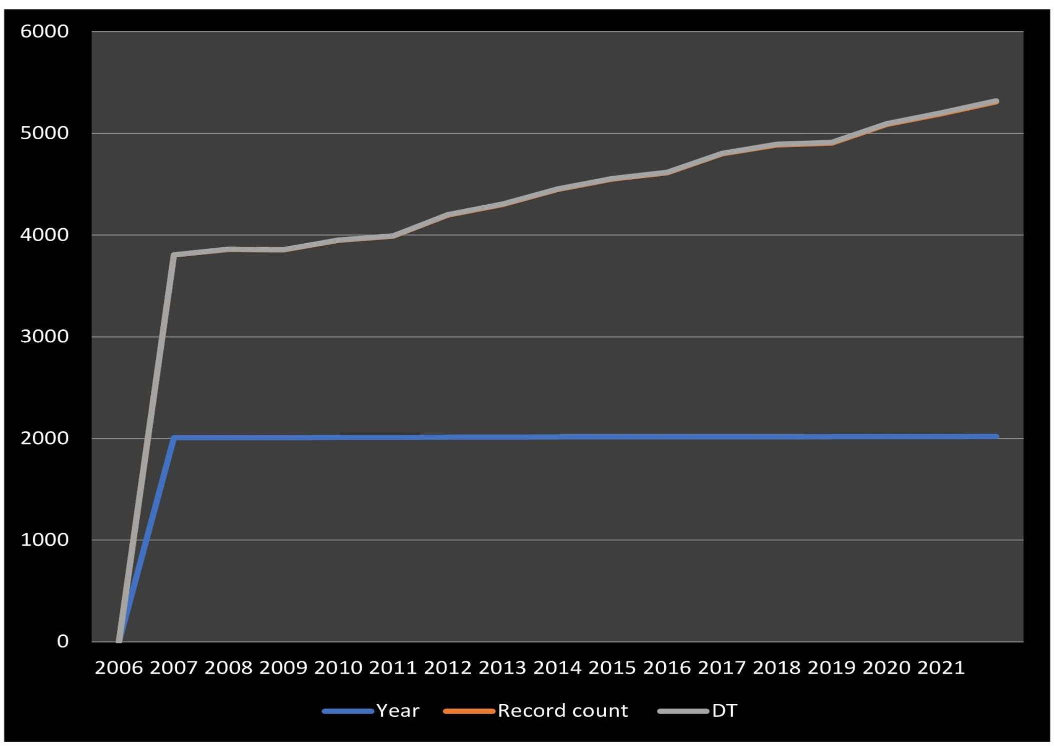

Figure 4. Doubling Time

The maximum RGR value was 0.409 in 2007, followed by 0.302 in 2008. At the same time, the lowest RGR value was found in 2018, 2019, 2020 and 2021, and the average mean relative growth rate was 0.267 from 2006 to 2011, the Relative growth rate was 0.133 from 2012 to 2016, the relative growth rate was down 0.080 from 2017 to 2021. Therefore, during this period, there was no noticeable growth in literature. The study's results clearly showed a declining trend of relative growth rate during the study period.

Figure 4 clearly explains that doubling the time required for articles /citations to get a 100% increase the publication size. The value of doubling time was increased from 1.694 to 8.875 from 2006 to 2021. The average value of the mean doubling time of publications increased from 2.818 to 7.675 during 2006 -2021. The average mean doubling time (DT) was 2.818 from 2006 to 2011; from 2012 to 2016, the doubling time was 5.265; again, it increased to 7.675 from 2017 to 2021. It could be noted that the value of doubling time gradually increased during the study period, and also noticed the relative growth rate decreased slowly, and doubling time increased.

The study's results analysed the association between the increasing rate of publication for each year and the time taken to double the publication size. Table 4 shows the statistical value of the relative growth rate (RGR) from 0.409 to 0.024, which indicates the decreasing trend of growth rate and the doubling time of publication starting from 1.694 to 8.875. Hence, there is an association between a decreasing growth trend and an increasing trend of doubling time. The figure and table clearly state the association between the decreasing trend of relative growth and the growing trend of doubling time during the study period.

S. No	Year	ARoG	AGR
1.	2006	0	0
2.	2007	0.970	-0.03
3.	2008	1.004	0.004854
4.	2009	0.950	-0.05203
5.	2010	0.980	-0.02009
6.	2011	0.905	-0.10455
7.	2012	0.954	-0.04755
8.	2013	0.940	-0.06373
9.	2014	0.959	-0.04185
10.	2015	0.976	-0.02363
11.	2016	0.933	-0.07118
12.	2017	0.970	-0.03089
13.	2018	0.993	-0.00662
14.	2019	0.941	-0.06231
15.	2020	0.966	-0.03454
16.	2021	0.964	-0.03654
	Mean 0.900		**-0.0387**

Table 4. Exponential Growth Rate of Organic Chemistry Research

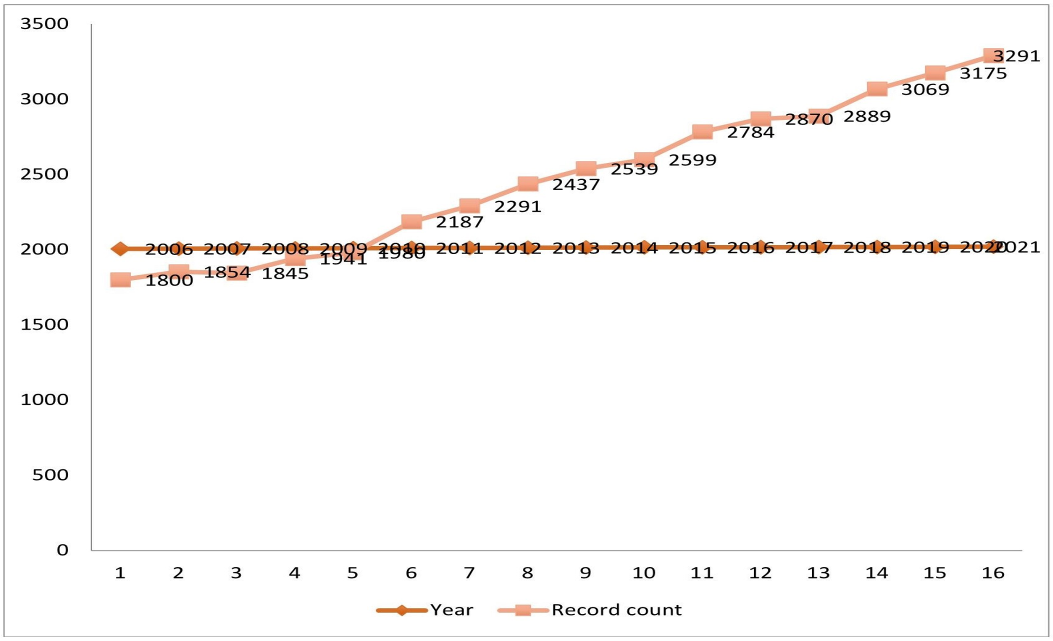

Figure 5. Annual Growth Rate in the Study Period

S. No.	Year	No of publications	CAGR
1.	2006	1800	0
2.	2007	1854	0.03843
3.	2008	1845	0.03652
4.	2009	1941	0.03683
5.	2010	1980	0.03355
6.	2011	2187	0.03227
7.	2012	2291	0.02587
8.	2013	2437	0.0229
9.	2014	2539	0.01895
10.	2015	2599	0.01635
11.	2016	2784	0.01486
12.	2017	2870	0.01051
13.	2018	2889	0.00859
14.	2019	3069	0.00818
15.	2020	3175	0.00438
16.	2021	3291	0.00225

Table 5. Compound Annual Growth Rate of Organic Chemistry

Table 5 describes the pattern and annual growth rate of publication over sixteen years. There was no stable growth from 2006 to 2010, but it was positive from 2011 to 2021. The publication trend was negative only in 2008, and in the remaining years, The publication trend was more positive than at the beginning. The annual growth rate ratio is also calculated using the present number of publications divided by the past number of publications for all the years. The mean average growth ratio was 0.900.

The topmost annual growth rate was found in 2021 (-0.03654), and the lowest was found in 2006 (-0.03). The annual ratio of growth was very high in 2020 (0.966). The results showed that the overall publication trend was slowly growing, and the overall yearly average publication growth rate was -0.0387.

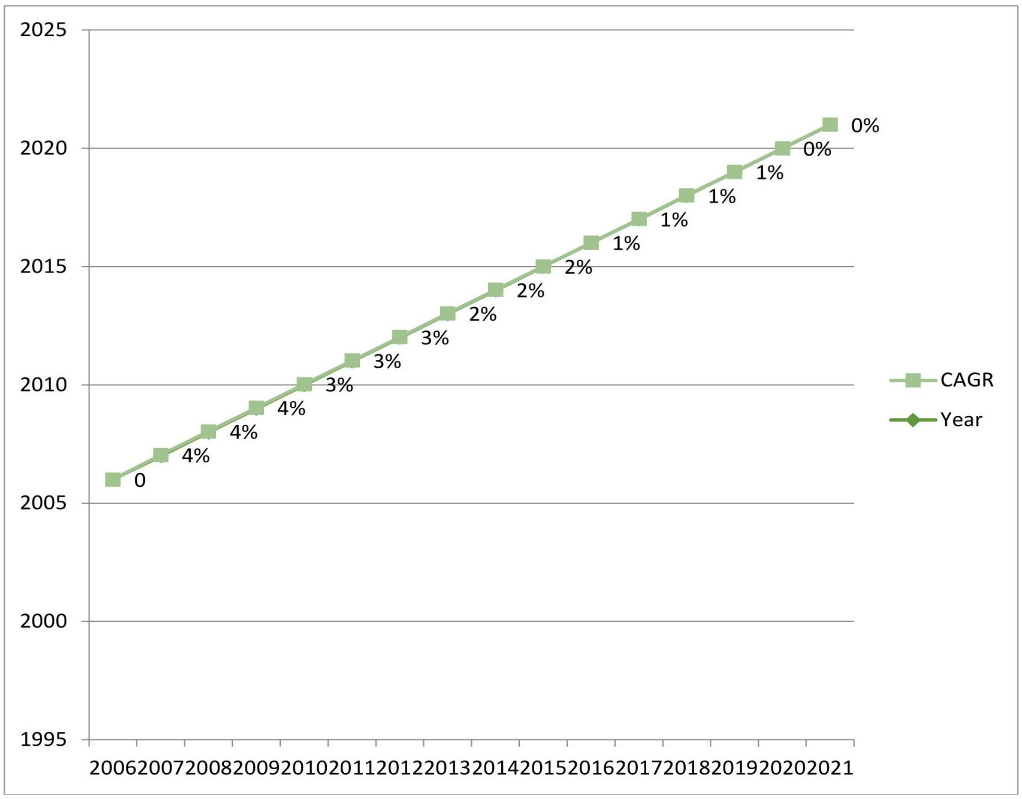

Figure 6. Compound Annual Growth Rate of Organic Chemistry

Table 6 shows organic chemistry's compound annual growth rate from 2006 to 2021. The CAGR is calculated using the n^{th} root of the total percentage of age growth rate, where n indicates the number of years in the period being considered. The yearly output of publications is increasing slowly year by year. However, there is a fluctuation because there is no constant growth of publications during the study period. It can be noted from Figure 6 that the Compound's annual growth was converted to a percentage of growth for each year. The annual growth rates of publications gradually decreased from 0.03843, 4% in 2006 to 0.00225, 0% in 2021. This indicates the compound annual growth rate of publication in organic chemistry is a downward trend.

The exponential growth rate of publications in organic chemistry from 2006 to 2021 is shown in Table 4.8 and Figure 4.8. This is the number of confirmed publications broken down by year; note that the growth rate is not constant. The doubling time was also roughly increased, and the growth was computed based on the number of publications year-over-year. Plotting an exponential graph with a trend line using the data demonstrates the R^2 -

S. No.	Year	Record	Expo. Grow yt1/yt0
1	2006	1800	0
2	2007	1854	0.461
3	2008	1845	0.857
4	2009	1941	0.892
5	2010	1980	0.899
6	2011	2187	0.924
7	2012	2291	0.927
8	2013	2437	0.957
9	2014	2539	0.966
10	2015	2599	0.981
11	2016	2784	0.993
12	2017	2870	0.994
13	2018	2889	0.994
14	2019	3069	0.997
15	2020	3175	0.998
16	2021	3291	0.999
	Mean	**39551**	**0.864**

Table 6. Exponential Growth Rate of Organic Chemistry Research

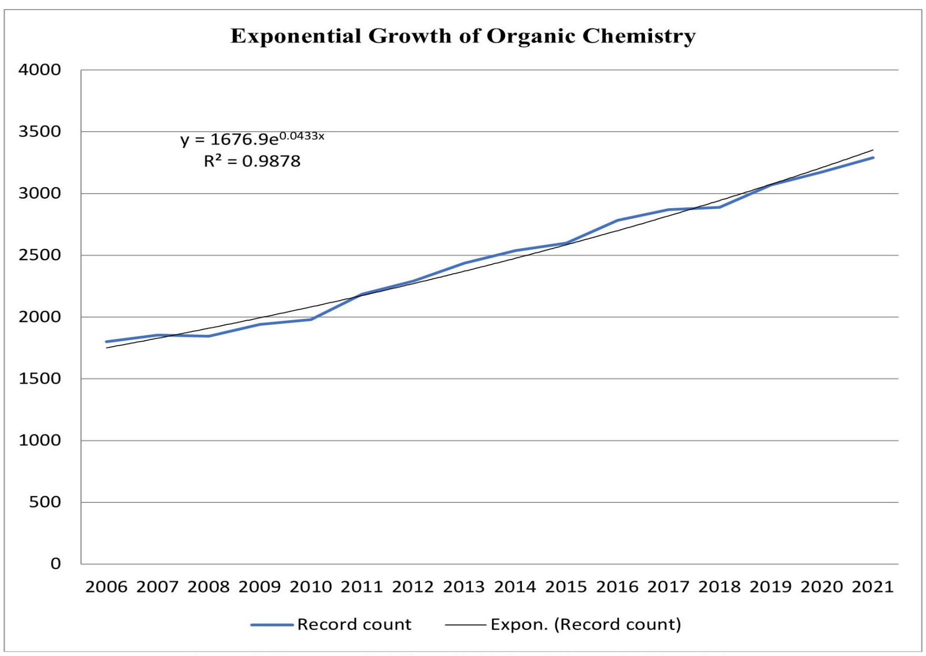

Figure 7. Exponential Growth Rate of Organic Chemistry

value of publications made during the study period. R^2 fitness is a value that ranges from 0 to 1. In this case, the R^2 value of 0.986 indicates the fitness of growth observed in the field of organic chemistry over the time under consideration. As a result, the publication's exponential growth model has convincingly demonstrated that the R^2 value of 0.986 indicates a sizable quantity of growth during the research period.

5. Conclusion

The study covered literature on the research productivity of organic chemistry published by the Web of Science database from 2006 to 2021. Organic Chemistry directly influences the sustainable development of agriculture, medicine, and environmental science to boost research productivity and publications.

Science is the fundamental facts or truths of all spheres in human life that play a crucial role in an individual's or nation's overall development. At present, the critical worth paying attention to the human being is to lead a healthy life forever. Hence, we select organic chemistry as a research field associated with science and human life. Therefore, we analysed the research productivity of organic chemistry using the Web of Science from 2006 to 2021. Scientometrics is the study of measuring science, science communications, and science policy. A scientometric technique encompasses many tools to describe the subject area, pattern of citation, characteristics of cited materials and their frequency, subject distribution, and also to look for changes in these characteristics over time. Gross & Gross (1927) say citation analysis is an indicator to measure the citation frequency of journals and significant journal tools. Assessing research quality requires a systematic approach to accomplish the research goals. The researcher found important insights into organic chemistry from the past sixteen years. The study shows that the growth rate of organic chemistry continued to increase from 2009 to 2021, and in 2008, the growth rate slightly decreased.

The USA, China, Japan, Germany, and India were the most productive countries. However, more effort is required to promote the quality of research and raise awareness of organic chemistry worldwide.

References

[1] Dwivedi, S., Kumar, S., Garg, K. C. (2015). Scientometric profile of organic chemistry research in India during 2004–2013. *Current Science, 109*(5), 869-877.

[2] Nagarkar, S. (2014). A bibliometric analysis of publications of the Chemistry Department, University of Pune, India, 1999-2012. *Annals of Library and Information Studies, 61*(2), 85-92.

[3] Kumar, K. A. (2014). Scientometric study of digital literacy in online library information science and technology abstracts (LISTA). *Library Philosophy and Practice, 1*(1), 13.

[4] Ramin, S., Gharebaghi, R., Heidary, F. (2015). Scientometric analysis and mapping of scientific articles on diabetic retinopathy. *Medical Hypothesis, Discovery and Innovation in Ophthalmology, 4*(3), 81.

[5] Murugan, M., Saravanakumar, R., Thirumagal, A. (2019). Lotka's law and pattern of author productivity of information literacy research output. *Library Philosophy and Practice (e-journal), 2509*.

[6] Sampaio, R. B., Fonseca, M. V. D. A., Zicker, F. (2016). Co-authorship network analysis in health research: Method and potential use. *Health Research Policy and Systems, 14*(1), 1-10.

[7] Guskov, A., Kosyakov, D., Selivanova, I. (2016). Scientometric research in Russia: Impact of science policy changes. *Scientometrics, 107*, 287-303.

[8] Maz-Machado, A., Madrid, M. J., Jiménez-Fanjul, N., León-Mantero, C. (2017). An empirical examination of Lotka's law for information science and library science. *Pakistan Journal of Information Management & Libraries, 19*, 37-51.

[9] Garg, K. C., Tripathi, H. K. (2017). Bibliometrics and scientometrics in India: An overview of studies during 1995-2014. *Part I: Indian publication output and its citation impact*.